IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

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SECTION MILL FOR WELLS

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I. TITLE: "SECTION MILL FOR WELLS"

II. BACKGROUND OF THE INVENTION

1. Field of the Invention.

The present invention relates to a section mill for wells, and more particularly, to a section mill that permits a user to extend the cutting performance of the apparatus without retrieving it from the well.

2. Description of the Related Art.

In the operation of oil wells, it is common during the maintenance stage to abandon the deepest portion of the casing (when it is in poor conditions) and open a casing window to install a new casing portion, typically, at an angle with respect to the previous casing, to reach oil deposits through a new path. Section mills are utilized to mill portions of a casing to accomplish this. In doing so, the casing needs to be cut from inside the casing and, subsequently, longitudinally reduced. The blades wear off and the conventional mills need to be retrieved to replace the blades and reinsert the mill.

Many designs for section mills have been designed in the past. The present invention includes a second set of blades that is deployed after the first set has been consumed milling the casing portion being replaced. This obviates the time consuming task of taking out the section mill assembly to change the used up set of blades and replace it with a new one.

Applicant believes that the closest reference corresponds to U.S. patent No. 5,074,355 issued to Lennon on December 24, 1991 for a section mill with multiple cutting blades. Lennon's patented section mill for cutting through well casing includes multiple sets of cutting blades which are selectively engaged to continue cutting operations as blades dull. The cutting blade sets are selectively indexable such that as a first set dulls or fails a succeeding set can be utilized following retraction of the first set. The section mill also includes a central mandrel having offset cammed surfaces, which engage the cutting blades and cause them to expand outwardly. The mandrel is axially displaceable by a piston affected by hydraulic pressure. As the mandrel is axially displaced the indexed cutting blades are expanded by the cammed surface. Indexing is accomplished by a cam drum, which allows the mandrel to be rotated relative to the cutting blades in order to align the next cammed surfaces with their respective cutting blades.

However, it differs from the present invention because a mandrel for indexing the blades is not required. In the present invention the second set of blades is automatically deployed once the cut section of the casing is reached. Subsequently, the second (or other blades) will not be used until the first blade is completely worn off. This simpler approach eliminates several critical elements required in Lennon's section mill.

Other patents describing the closest subject matter provide for a number of more or less complicated features that fail to solve the problem in an efficient and economical way. None of these patents suggest the novel features of the present invention.

III. SUMMARY OF THE INVENTION

It is one of the main objects of the present invention to provide a tool for extending its performance of cutting a casing at predetermined depths in a well without requiring the withdrawal of the section mill tool.

It is another object of this invention to provide a section mill tool for wells that includes at least two sets of blade assemblies wherein at least one of the sets is distended after an initial section of the casing has been cut.

It is still another object of the present invention to provide a tool that is easy to install and operate.

It is yet another object of this invention to provide such a tool that is inexpensive to manufacture and maintain while retaining its effectiveness.

Further objects of the invention will be brought out in the following part of the specification, wherein detailed description is for the purpose of fully disclosing the invention without placing limitations thereon.

IV. BRIEF DESCRIPTION OF THE DRAWINGS

With the above and other related objects in view, the invention consists in the details of construction and combination of parts as will be more fully understood from the following description, when read in conjunction with the accompanying drawings in which:

Figure 1 shows a partial cross sectional view of the section mill tool assembly, inside an oil well bore.

Figure 2 is a cross sectional view of the section mill tool assembly, with the blades being distended against the casing by fluid pressure. The first set of blades start cutting the internal wall of the casing while the second set of blades comes in slidable contact with the casing.

Figure 3 represents a cross sectional view of the section mill tool assembly shown in the previous figures with the first set of blades beginning the casing sectioning work.

Figure 4 shows a cross sectional view of the section mill tool assembly, with the first set of blades fully distended sectioning the casing and the second set of blades continues in slidable contact with the internal walls of the casing.

Figure 5 shows a cross sectional view of the section mill tool assembly, with the first set of blades having sectioned a portion of the casing and being partially worn out. The second set of blades continues to be in slidable contact with the internal walls of the casing.

Figure 6 illustrates a cross sectional view of the section mill tool assembly, with the first set of blades having sectioned a sufficient portion of the casing so its blades are almost completely used up and the second set of blades has reached the portion already cut by the first set of blades allowing it now to fully distend.

Figure 7 shows a cross sectional view of the section mill tool assembly, with the first set of blades completely used up and the second set is advancing in the already cut portion.

Figure 8 shows a cross sectional view of the section mill tool assembly, with the first set of blades completely used up and the second set of blades have advanced to reach the portion of the casing where the sectioning operation needs to continue.

Figure 9 shows a front isometric view of one of the blades used in the first set of blades.

Figure 10 shows a rear isometric view of one of the blades used in the first set of blades.

Figure 11 is a cross sectional view of the blade shown in figure 9 taken from line 11-11.

Figure 12 shows a front isometric view of one of the blades used in the second set of blades.

Figure 13 shows a rear isometric view of one of the blades used in the second set of blades.

Figure 14 is a cross sectional view of the blade shown in figure 12 taken from line 14-14.

Figure 15 shows an isometric view of the tubular shaft assembly (partially shown) with tubular shaft assembly and second set of blades mounted therein.

Figure 16 is a cross section shown in figure 15 taken from line 16-16 showing the disposition of the blade assembly with respect to the shaft assembly and the triangular cross section of the teethed portion.

V. DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to the drawings, where the present invention is generally referred to with numeral **10**, it can be observed that it basically includes casing **15**, cylindrical assembly **20**, tubular shaft assemblies **30** and **40** and first and second sets of blades **50** and **60**, and their respective spring bias assemblies **70** and **80**.

An oil well bore typically includes casing **15** that extends downwardly several thousand meters. Sometimes a portion collapses making it inoperational. Rather than closing the oil well and wasting the associated infrastructure investment, a portion of the casing above the problem area is sectioned and branched out to reach oil deposits through a different path. With the present invention, the second set of blades is

deployed and used after the first set has been worn out completely. In sum, the cutting and reliability capabilities of the section mill is extended.

In figure 1, the tool subject of the present application is shown within an oil well casing, as it is being lowered to the desired location. There is no pressurized fluid applied yet. Cylindrical assembly **20** extends for several thousand meters and it includes central through opening **28** through which a source of a pressurized fluid (typically water) is forced through. Uppermost end **22** is rotably supported at the well entrance at the top. Assembly **20** includes apertures **24** and **26** at predetermined distances from the distal end **23**.

Tubular shaft assembly **30** includes central through opening **38** that is coaxially aligned with central opening **28** of cylindrical assembly **20**. Tubular shaft assembly **30** also includes ends **32** and **33** and teethed portions **34** at a predetermined distance from end **32**. Tubular shaft assembly **30** is coaxially housed within cylindrical assembly **20.** Packing member **36** seals shaft assembly **30** with respect to cylindrical assembly **20**. Packing member **36** is implemented, in the preferred embodiment with an O-ring.

Tubular shaft assembly **40** includes ends **42** and **43**, central through opening **48** and teethed portions **44** (as best seen in figure 15) at a predetermined distance from end **42**. Tubular shaft assembly **40** is coaxially housed within tubular shaft assembly **30**. Packing member **46** seals shaft assembly **40** with respect to shaft assembly **40**. Packing member **46** is implemented, in the preferred embodiment with an O-ring.

First set of blades **50** (upper ones) is rotatably mounted to cylindrical assembly **20** at aperture **24.** First set of blades **50** includes, in the preferred embodiment, three blade members **52** selectively movable between two extreme positions. Blade members **52** are cooperatively adapted to coact with teethed portions **34**. Blade members **52** are in a substantially coaxial alignment with cylindrical assembly **20** in one of the extreme positions and are in a substantially perpendicular relationship with respect to cylindrical assembly **20** protruding radially outwardly therethrough in the other extreme position. In the latter extreme position blade members **52** are brought in operational contact with casing **15**. Blade member **52** includes smooth rounded corner **53**, milling edge **54**, internal channel **56**, cutout **57** and teethed portions **58**. Smooth corner **53** comes in slidably contact with the interior surface of casing **15** when moving from the first extreme position towards the other extreme position. Teethed portion **58** has through opening **59** with cooperative dimensions to receive pin member **25** mounted to cylindrical assembly **20.** In the preferred embodiment, pin member **25** is securely locked with a fastening member. Teethed portions **58** of blade members **52** cooperatively coact with teethed portions **34** of shaft assembly **30**. Milling edge **54** of blade member **52** starts its cutting operation only after section mill **10** advances downwardly a sufficient distance to permit blades **52** to distend radially outwardly through casing **15** and blade members **62** have wore out. Blade member **52** is shown in more detail in figures 12; 13 and 14. Member **52** also includes, in the preferred embodiment, abrasive portion **51** that in turn includes steel support plates **55** sandwiched by abrasive material layers **55'**. One of the preferred and hardest abrasive materials used for the present invention is tungsten carbide.

Second set of blades **60** is mounted to cylindrical assembly **20** at a predetermined distance from end **23.** The distance between the location of the second set of blades 60 and end **23** is shorter than the distance between the location of first set of blades **50** and end **23.** Blade members **62** are cooperatively adapted to coact with teethed portions **44**. Teethed portion **68** has through opening **69** with cooperative dimensions to pivotally receive pin member **27** mounted to cylindrical assembly **20.** In the preferred embodiment, fastening member **29** securely locks pin member **27,** as best seen in figures 15 and 16. Second set of blades **60** includes, in the preferred embodiment, three blade members **62** selectively movable between two extreme positions. Blade members **62** are in a substantially coaxial alignment with cylindrical assembly **20** in one of the extreme positions and are in a substantially perpendicular relationship with respect to cylindrical assembly **20,** and protruding radially outwardly through, in the other extreme position. In this other position, blade members **62** are brought in operational contact with casing **15**. Blade member **62** is shown in more detail in figures 9; 10 and 11. In the preferred embodiment, abrasive portion **61** includes steel support plates **65** sandwiched by abrasive material layers **65'**. Tungsten carbide is the preferred abrasive material used. Blade member **62** also includes cutting corner **63,** milling edge **64,** internal channel **66,** cutout **67** and teethed portions **68**. Cutting corner **63** is designed to start the cutting operation from the internal surface of casing **15**.

Spring bias assembly **70** urges end **43** of tubular shaft assembly **40** towards end **22** and is overcome by the application of a source of pressurized fluid through central through opening **28** of cylindrical assembly **20** coacting against the surface of end **43** of tubular shaft

assembly **40,** so that blade members **62** are brought against casing **15** to start the cutting operation. Corner **63** of blade member **62** comes in contact with the internal surface of casing **15** and the cutting operation starts.

Spring bias assembly **80** urges end **33** towards end **22** and overcome by the application of a source of pressurized fluid through cylindrical assembly **20** coacting against end **33** of tubular shaft assembly **30,** so that blade members **52** are brought against casing **15** in slidably contact therewith thereby starting the cutting operation only after the mill **10** has advanced a predetermined distance and blades **62** have been consumed.

The foregoing description conveys the best understanding of the objectives and advantages of the present invention. Different embodiments may be made of the inventive concept of this invention. It is to be understood that all matter disclosed herein is to be interpreted merely as illustrative, and not in a limiting sense.